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Abstract

This summary of forest pest conditions in British Columbia and the Yukon Territory in 1985 highlights pests that are or may become major forest management problems. It was compiled from records and field reports of 11 Forest Insect and Disease Survey technicians with contributions from forest agencies and industry. Forty-four forest pests are discussed and some predictions are made for 1986.

Mountain pine beetle killed mature pine over 291 775 ha, mainly in the Cariboo Region. Cold temperatures in October 1984 killed a high percentage of the overwintering broods, but infestations will continue at reduced levels in all regions in 1986. **Spruce beetle** infestations declined to 15 800 ha mainly in the Prince Rupert and Prince George regions. The area of Douglas-fir forests defoliated by **western spruce budworm**, mainly in the Kamloops Region, expanded threefold to 214 000 ha and is forecast to continue to expand in 1986. Localized populations of **Douglas-fir tussock moth** defoliated Douglas-fir over 70 ha in the Kamloops Region, after a previous infestation collapse in 1984. Infestations of **Western hemlock looper** collapsed due to the high numbers of larval parasites and a nuclear polyhedrosis virus. **Western blackheaded budworm** populations defoliated western hemlock over 45 600 ha, mainly on the Queen Charlotte Islands, also on the mainland coast, in the Fraser Valley and in the Cariboo and Kamloops regions. Although populations declined in the Revelstoke area, defoliation is forecast to continue in coastal areas in 1986. **Larch casebearer** and **larch sawfly** defoliation and **larch needle diseases** declined but **larch budmoth** expanded. **Black army cutworm** killed conifer seedlings, damaged buds, delayed planting schedules and defoliated herbaceous ground cover at numerous sites and is predicted to be widespread in 1986. **Forest tent caterpillars** defoliated nearly 59 000 ha of aspen and poplar in the Peace River area and the Prince Rupert Region.

Gypsy moth adults were trapped in the Fraser Valley for the third consecutive year but none on Vancouver Island and populations have not yet become established. **Pinewood nematode** was

not found, but native nematodes were isolated from pine, spruce and alpine fir. Six plots to monitor tree condition and possible **acid rain** effects were established and sampled.

Résumé

Le présent résumé sur les ravageurs des forêts de la Colombie-Britannique et du Yukon, en 1985, porte sur ceux qui posent ou peuvent poser de graves problèmes aux aménagistes. Il synthétise les observations et les rapports de 11 techniciens du RIMA, en intégrant les contributions des organismes et de l'industrie forestière. 44 ravageurs font l'objet de discussion et de prévisions pour 1986.

Le **dendroctone du pin ponderosa** a tué plus de 291 775 ha de pin à maturité, surtout dans la région de Cariboo. Même si les froids d'octobre 1984 ont tué un fort pourcentage des oeufs et des larves hivernants, les infestations se poursuivront dans toutes les régions en 1986, bien qu'à une intensité moindre. Les infestations du **dendroctone de l'épinette** se sont réduites à 15 800 ha, surtout dans les régions de Prince George et de Prince Rupert. La superficie des douglasières défoliées par la **tordeuse occidentale de l'épinette**, dans la région de Kamloops surtout, a triplé à 214 000 ha et elle devrait s'étendre en 1986. Des effectifs localisés de la **chenille à houppes du douglas** se sont attaqués à plus de 70 ha de douglas taxifolié, dans la région de Kamloops, après que l'infestation se fut résorbée en 1984. Les infestations de l'**arpenteuse de la pruche de l'Ouest** ont succombé au parasitisme élevé des larves et à un virus de la polyédrose nucléaire. La **tordeuse à tête noire de l'Ouest** a défolié 45 600 ha, surtout dans les îles Reine-Charlotte, sur la côte de continent et dans la vallée du Fraser, pour la première fois depuis un certain nombre d'années, ainsi que dans les régions de Cariboo et de Kamloops, pour la deuxième année consécutive. Même si les effectifs ont diminué dans la région de Revelstoke, la défoliation devrait se poursuivre dans les régions côtières en 1986. Il y

a eu recul du **porte-case du mélèze**, de la **tenthrede du mélèze** ainsi que des **maladies des aiguilles du mélèze**, mais progression de la **tordeuse du mélèze**, la **légionnaire noire** qui a tué les semis de conifères, endommagé les bourgeons, retardé la plantation et dévasté la couverture herbacée de nombreuses stations, devrait gagner du terrain en 1986. La **livrée des forêts** et la **livrée de l'Ouest** ont défolié près de 59 000 ha de peuplier et de peuplier faux-tremble dans la vallée de la rivière de la Paix et la région de Prince Rupert.

Des **spongieuses** adultes ont été capturées dans la vallée du Fraser pour la troisième année consécutive, mais non dans l'île Vancouver; les populations ne sont pas encore implantées. Le **nématode du bois des pins** n'a pas été décelé, mais des nématodes indigènes ont été isolés de pins, d'épinettes et de sapins subalpins. On a établi et soumis à des échantillonnages six parcelles de contrôle de l'état des arbres et des effets possibles des *pluies acides*.

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Introduction

The six Forest Insect and Disease Survey units of the Canadian Forest Service are responsible for producing an annual national overview of important forest pest conditions and their implications; maintaining surveys and records in support of quarantines; supporting forestry research through maintenance of records, herbaria and insect collections; and providing advisory services concerning forest insect and disease conditions. General surveys to detect and monitor important forest insects and diseases and environmental factors are conducted annually in the Pacific Region with the cooperation of the B.C. Ministry of Forests and other federal, provincial and municipal agencies and industry. The close cooperation with research programs and staff at the Pacific Forestry Centre and other CFS centres continues to be an important contribution.

This regional report reviews the status and impact of the major insects and diseases and effects of environmental factors (acid rain) on conifer and broadleaf forests in British Columbia and the Yukon Territory in 1985 and forecasts some pest conditions for 1986. Tables and maps providing, respectively, amounts of damage and locations of major insect infestations are included. Numbers and volume of trees recorded in tables are estimates. Annual damage trends and locations of infestations can be determined by comparison to previous years' reports. The information is compiled largely from observation and field records of eleven Forest Insect and Disease Survey technicians collected during their field assignments from late May to October. More

detailed information on the status of forest pests for six provincial forest regions and the Yukon Territory is available in reports compiled by the following FIDS rangers:

- Cariboo Forest Region
 - Dick Andrews
- Kamloops Forest Region
 - Bob Erickson and Bob Ferris
- Nelson Forest Region
 - Peter Koot and Rod Turnquist
- Prince George Forest Region
 - Rod Garbutt and Jim Loranger
- Prince Rupert Forest Region
 - Leo Unger and Alan Stewart
- Vancouver Forest Region
 - Nick Humphreys and John Vallentgoed
- Yukon Territory
 - Jim Loranger

Other staff of the 1985 Forest Insect and Disease Survey project were:

- Allan Van Sickle, Head, Forest Insect and Disease Survey
- Lee Humble, Entomologist i/c Insectary and Collection
- Bob Duncan, Insectary Technician
- Erika Pass, Insectary Technician
- John Hopkins, Pathologist i/c Herbarium
- Daphne Lowe, Herbarium Technician
- Terry Shore, Pest Survey Sampling Officer (to July)
- Walter Stanek, Mensuration
- Colin Wood, Chief FIDS Ranger
- Joan Strobbe, Secretary

Summary

Unusually low temperatures in late October 1984, which followed recordbreaking high temperatures earlier in the month, killed significant numbers of mountain pine beetle and spruce beetle in parts of the interior. Winter weather was generally normal but in mid-May tree and insect development was up to three weeks later than normal due to cool weather. Warmer temperatures in the second half of May accelerated larval development to normal levels by early June. Late frost in June in the interior killed newly developed buds of white and Sitka spruce, hemlock, amabilis fir and Douglas-fir in parts of the Prince George, Prince Rupert and Cariboo regions. Immature pine in provenances in a plantation were severely affected and about 20 000 pine seedlings were killed at interior forest nurseries. July, August and September were the hottest and driest on record in most parts of the Province. This weather was optimum for insect development but detrimental to tree growth.

The delay of aerial surveys until the Fall in some regions, caused by the prolonged fire season, resulted in the delineation of some insect defoliated areas being affected by seasonal foliar color change and adverse weather.

The area of recent pine mortality, killed by **mountain pine beetle**, the most destructive pest of mature forests in British Columbia, declined significantly to 291 775 ha from 482 000 ha in 1984. In addition, about 470 000 ha of unsalvageable lodgepole pine in the southwestern part of the Cariboo Region killed by the beetle prior to 1984 have been deleted from the inventory. Infestations expanded slightly in the Kamloops and Prince George regions, declined in the Nelson and Prince Rupert regions and were unchanged in the Vancouver Region. Population declines are predicted for most regions in 1986. **Pine stem and branch diseases** were common and widespread but needle diseases declined. A new outbreak of **pine sawfly** near Vavenby in the Kamloops Region severely defoliated older needles of lodgepole pine over 100 ha, and a **pine needle sheathminer** severely discolored regeneration pine near Salmon Arm. There was no evidence of **pinewood nematode** in 80 province-wide

samples, but native nematodes were isolated from 15 samples from four conifer hosts. Adult male **European pine shoot moths** were caught in traps on southern Vancouver Island and in the Okanagan Valley, but damage to exotic pine was very light and native pines were not affected.

Declines in the area within which mature spruce were killed by **spruce beetle** to 15 800 ha, mainly in the Prince Rupert and Prince George regions, continued for the third consecutive year. Isolated infestations persist in the Cariboo, Kamloops, Nelson and Vancouver regions. Attacks could increase in 1986 when two-year-cycle populations emerge from 1984 windthrow in parts of the Cariboo, Prince George and Prince Rupert regions. Mature and immature spruce were killed by **spruce aphid** at scattered east coastal areas on the Queen Charlotte Islands following periodic years of severe defoliation, but populations declined in mainland coastal areas of the Prince Rupert Region and on Vancouver Island.

A threefold increase in the area to 214 000 ha of Douglas-fir defoliated by **western spruce budworm** occurred in the Cariboo and Kamloops regions and a small area in the Nelson Region. Most of the increase occurred in the Thompson River drainage in the Kamloops Region and north of Clinton in the Cariboo Region. Defoliation occurred for the first time since 1976 west of Lillooet and southwest of Oliver. Localized populations defoliated stands east of Bridesville for the eighth successive year. Defoliation is forecast to be as severe and as widespread in 1986. **Douglas-fir tussock moth** severely defoliated Douglas-fir in only four pockets totaling 70 ha near Savona in the Kamloops Region after populations collapsed elsewhere in the Region in 1984. As only two egg masses and five male moths were found in pheromone-baited traps, defoliation is not expected to occur in 1986.

Eastern spruce budworm lightly defoliated valley bottom fir-spruce in the Fort Nelson River Valley and in southeastern Yukon, but declined to several small patches from 7300 ha in 1984, in the Liard River Valley. Early instar larvae of **two-year cycle budworm** moderately defoliated 6700

ha in areas in the Willow and Bowron River valleys and Horsefly Lake in the Prince George and Cariboo regions. **One-year cycle budworm** in the western part of the Prince Rupert Region collapsed, following a decline in 1984 due in part to the high incidence of infection by the pathogen, *Beauveria bassiana*.

A new outbreak of **western blackheaded budworm** moderately and severely defoliated western hemlock over 45 600 ha mainly on the Queen Charlotte Islands, in the Quesnel Lake area in the Cariboo Region, in Wells Gray Provincial Park, and from Mabel Lake to the Upper Adams River drainage in the Kamloops Region, and near Harrison Lake in the Vancouver Region. Infestations declined to 150 ha near Revelstoke, down from 19 000 ha in 1984 the first year of outbreak. Increasing populations and severe defoliation are forecast for the Queen Charlotte Islands and parts of the north mainland coast, but only trace or light defoliation in the Cariboo, Kamloops, Nelson and Vancouver regions. **Western hemlock looper**, mainly in decadent western hemlock-western red cedar stands in the Cariboo, Kamloops and Nelson regions, collapsed after stands over 13 350 ha were defoliated in 1984. Egg parasitism and infection of larvae by a nuclear polyhedrosis virus were major factors.

Discoloration of western larch by **larch casebearer** was less severe than in 1984 over about 40 000 ha between Elko and Creston in the Nelson Region. In western larch stands in the West Kootenay and adjacent parts of the Kamloops Region, casebearer populations remained low, attributed to periodic parasite releases of introduced parasites. More than 3500 European parasitic wasps were released in six casebearer infested western larch stands in the East Kootenay and one stand in the West Kootenay area of the Nelson Region. **Larch sawfly** continued for the second year in tamarack stands in the southern Yukon but collapsed in western larch stands near Fernie in the Nelson Region. Increased **larch budmoth** moderately and severely defoliated western larch over 14 800 ha in more than 70 areas in the West Kootenay and adjacent areas of the Kamloops Region, up from 1100 ha in 10 areas in 1984.

Increased numbers of **black army cutworm** larvae in recently burned sites, mainly in the Prince Rupert Region and in the Cariboo and Prince George regions, killed and severely defoliated re-

cently planted pine, spruce and Douglas-fir seedlings. High numbers of adults and the low incidence of parasites and virus indicate a potential for damage in 1986 to conifer seedlings in or near recently infested sites in the Cariboo, Prince George and Prince Rupert regions. A similar potential exists in some areas burned by wild fires in 1985, particularly in the Nelson Region.

Several defoliators of deciduous forest trees were common including: **forest tent caterpillar** which severely defoliated trembling aspen stands over 58 000 ha from south of Pouce Coupe to Fort St. John in the Prince George Forest Region; 900 ha between Hazelton and Moricetown in the Prince Rupert Region and pockets near Trail in the Nelson Region. **Western tent caterpillar** severely defoliated a variety of trees and shrubs in the Fraser Valley, Sunshine Coast, Lower Mainland and east coastal areas of Vancouver Island. The introduced **satin moth** was found for the first time north of latitude 52° at Williams Lake where a group of black cottonwood was moderately defoliated. Defoliation of scattered trees and shrubs was common in the Kamloops and Nelson regions and in Victoria.

Quarantine related surveys were conducted for several pests including:

- **Gypsy moth** populations have not become established in British Columbia to date and defoliation has not been observed. The only positive trap catches in 1985 were 14 moths in 13 traps near Chilliwack, one at Cultus Lake, near Abbotsford and north of Cache Creek. Designated areas of Courtenay and Chilliwack were treated in 1985, based on the presence of moths in 1984 and egg masses.
- **Balsam woolly aphid** populations, but little damage, were found on mature grand fir near Parksville on Vancouver Island, inside the current quarantine zone but an extension of the infestation zone. Lightly infested *Abies amabilis* stock were found in a seed orchard near Victoria. Surveys of nursery stock and 10 natural stands on Vancouver Island and nine stands in southeastern British Columbia, north of recent collections recorded in Idaho, were negative.
- Adult male **European pine shoot moths** were attracted to pheromone-baited traps placed on southern Vancouver Island and in the Okana-

gan Valley. There was little evidence of significant damage to exotic pines and none to native pines.

- Although native larch cankers were found on western larch in southeastern British Columbia, there was no evidence of **European larch canker**, an introduced and serious threat to tamarack in eastern Canada.
- Native bacterial and insect-associated nematodes, but not **pinewood nematode**, were isolated from lodgepole pine and other conifers and from a cerambycid vector.

- Large numbers of larvae, pupae and adult beetles of two exotic woodborers, *Megacyllene* sp. and *Placosternus* sp., were recovered from cut stem and branches of mesquite, *Prosopis juliflora*, which originated from Monterrey, Mexico. The material stored in Victoria and Vancouver was destined for use in restaurant grills.

Six permanent plots were established in five Forest Regions to detect and monitor early signs of **acid rain**. This was part of a national standardized system initiated in 1984 when three plots were established.

Pine pests

Mountain pine beetle

Dendroctonus ponderosae

The mountain pine beetle, the most damaging forest insect in British Columbia, continued to spread and intensify in mature lodgepole pine and some western white pine forests from the International border to north of Kitwanga (Map 1). More than 9 000 recent infestations covered about 291 775 ha (Table 1), more than the area destroyed by forest fires in the Province in 1985. On an additional 470 000 ha, more than 30% of the mature pine had been killed prior to 1984, making this uneconomic to harvest.

The largest losses continue to be in the Cariboo Region where at least 189 500 ha of mature lodgepole pine killed by 1984 attack were mapped. The area within which pine mortality occurred increased in the Kamloops Region to 72 200 ha as a result of expansion of chronically infested stands, and increased in the Prince George Region to 1025 ha. Declines, due to host depletion, weather and control programs occurred in the Nelson Region down to 13 850 ha and in the Prince Rupert Region down to 11 000 ha. Infestations remained largely unchanged in the Vancouver Region, over 4200 ha.

Brood assessments earlier in the year showed

static or increasing populations at about half (54%) of 41 areas in five regions. Despite high brood mortality in some areas, particularly the Cariboo Region, progeny survived under thick bark and in the lower butt levels. Population trends based on the ratio of surviving overwintering progeny to parent beetles ranged from 0 to 11.8; a factor of 2.6 or greater indicating static to increasing populations.

The level of current attack in green trees, which averaged 17% in 52 areas, was similar to 1984. This indicates continuing populations in all regions but with great variation among stands and regions. In the Cariboo Region an average of 2% (range 0-10%) of the trees were attacked in 22 cruise strips. Current attack in other regions averaged from 12% in Kamloops to 27% in the Prince Rupert Region, where up to 57% of the green trees were attacked.

Lodgepole pine mortality in the Cariboo Region occurred in more than 4000 infestations totaling 189 500 ha which contained 7.1 million trees (3.0 million m³) killed by 1984 beetle attack. The area represents about 65% of the provincial total. An additional 470 000 ha of lodgepole pine forest mainly in the western part of the region contained 30% or more pine killed prior to 1984. Spot infestations continued to spread northward towards

Map 1

FOREST INSECT AND DISEASE SURVEY

1985

Areas where recent tree
mortality was detected
during aerial surveys.

Mountain pine beetle

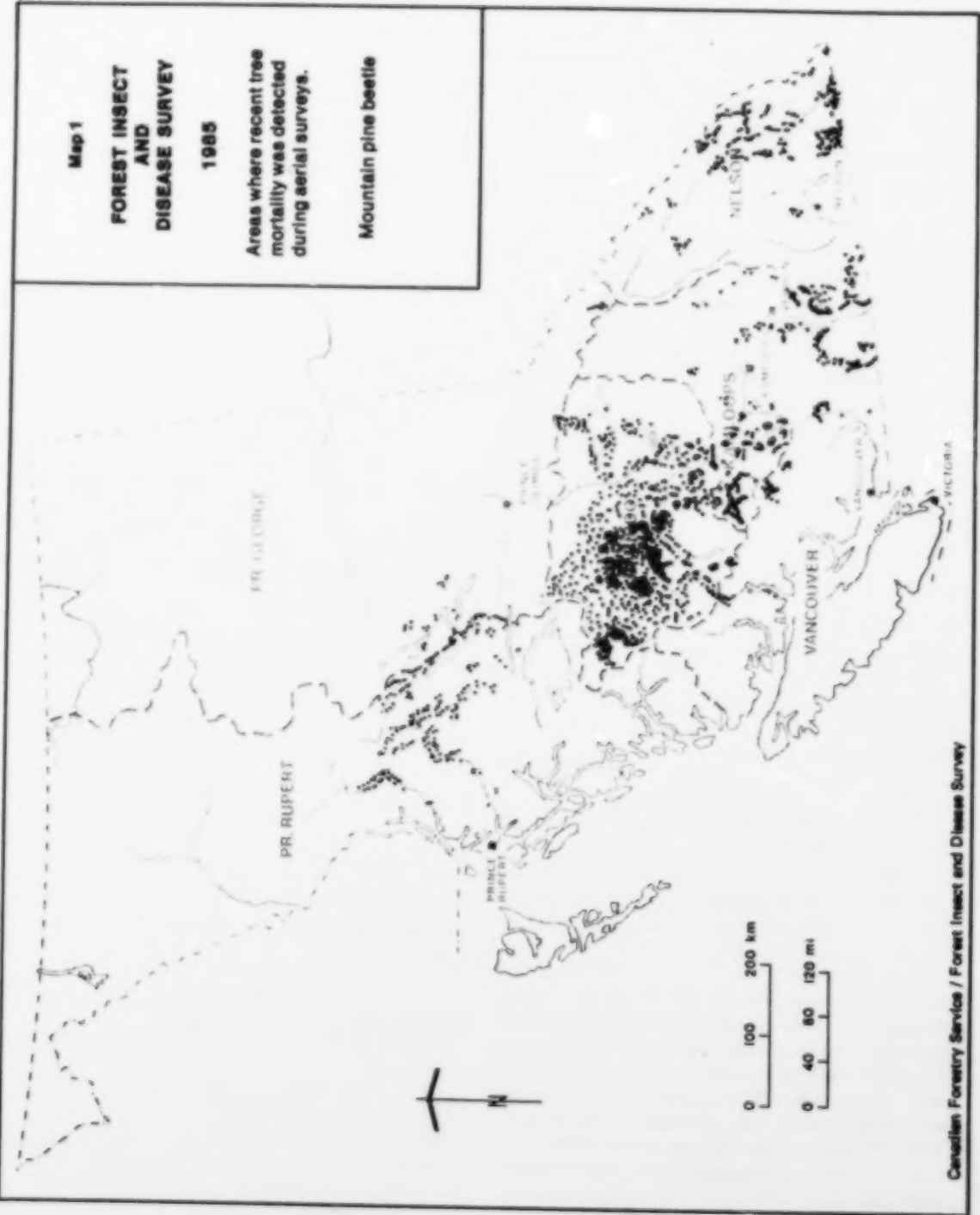


Table 1. Number and area of mountain pine beetle infestations by provincial forest regions, based on recently killed trees recorded by aerial and ground surveys, British Columbia, 1985

Region	No. of Infestations	Area (ha)	Trees Killed ^a		Stands ^e Cruised	Average % of Trees ^b				
			Number (000)	Volume (000m ³)		H	C	R	G	P
Cariboo	4000	189 500 ^c	7110	3058	22	75	2	4	14	5
Kamloops	1800	72 200	4533	2123	8	45	12	18	18	7
Nelson	1800	13 850	902	326	7	52	19	9	9	11
Prince George	135	1025 ^d	18	11	0	—	—	—	—	—
Prince Rupert	1550	11 000 ^c	937	910	10	53	27	12	6	2
Vancouver	150	4200	102	86	5	37	22	16	17	8
TOTAL	9435	291 775	13 602	6514	52	52	17	12	12	7

^a Trees attacked in 1984, discolored in 1985.

^b H = Healthy; C = Current, attacked in 1985; R = Red, attacked in 1984; G = Grey, attacked prior to 1984; P = Partial, or strip attack.

^c Estimates include data from B.C. Ministry of Forests.

^d Numerous widespread spot (0.25-ha) infestations.

^e Stands located in younger infestations and may not represent average conditions.

the Prince George and Prince Rupert regional boundaries; from Alexis Creek and Tatla Lake to Nazko and Anahim Lake in the Anahim and Narcosli Supply Blocks. However, with reduction in the 1985 attack, pine mortality in the Region should be greatly reduced in 1986.

Infestations in the Kamloops Region increased for the third consecutive year in the Lillooet and Okanagan TSAs to 1800 which covered 72 000 ha and contained 4.5 million trees (2.1 million m³). About 80% of the trees over 25 000 ha within the infested area were killed in or prior to 1983. The expansion occurred in chronically infested stands in the Lillooet TSA from French Bar Creek near Lillooet to Goldbridge including Tyaughton, Relay and Mid creeks, and in the Stein River drainage near Lytton. In the Okanagan TSA pine mortality in chronically infested

stands expanded in Mission and Belgo creeks east of Kelowna, in Shorts, Trout and Hayes creeks west of the Okanagan Valley, and in the Ashnola River Valley south of Keremeos. Current attack declined slightly in eight areas to 12% (range 2-27%) from 15% in 1984. Tree mortality is expected to increase, however, in three infested areas including Jellicoe Creek near Hayes Creek in the Okanagan TSA where 27% of the trees were attacked in 1985.

An estimated 13 850 ha containing 902 000 recently killed lodgepole pine (326 000 m³) in 1800 infestations were mapped in the Nelson Region, down from 21 000 ha in 1984. Infestations from the International border to north of Golden, along the Alberta-B.C. border and in Kootenay National Park have declined for the fourth consecutive year. However, localized increases oc-

curred in chronically infested stands at Steamboat Mountain near Invermere. Although the incidence of current attack increased overall to 19% from 7% in 1984, the increases are expected to be mostly in the Invermere area.

In the Prince Rupert Region the overall area of lodgepole pine killed by 1984 attacks declined 25% to 11 000 ha mainly in the eastern part of the Region. Outbreaks continued in the Skeena River drainage between Hazelton and Terrace, in Harold Price Creek and in the Nass, Cranberry, Kispiox and Nilkitkwa river drainages. Harvesting and cut and burn programs have also contributed to the decline caused by a cool and wet 1984 summer and poor overwintering brood survival. Although current attack in green trees in 10 stands increased slightly to 27% (range 20-57%), indicating that localized infestations and tree mortality will continue in 1986, an overall slight decline in the area containing beetle-killed pine is expected.

The area of recent tree mortality in the Prince George Region increased to 1025 ha, largely in the Fort St. James area, south of Vanderhoof near the Cariboo Region border area, and near Valemount. Mortality of lodgepole pine and some western white pine declined significantly in mature stands in the Canoe area south of Valemount, where pine has been killed since 1976. Three localized infestations containing 110 recently killed lodgepole pine developed in and adjacent to Mt. Robson Provincial Park. This is about 20 km north of endemic beetle activity and 85 km west of Jasper National Park. A similar number of trees are newly attacked but control programs should continue to reduce populations in 1986.

Tree mortality continued in 150 scattered infestations over 4200 ha in the Vancouver Region, mainly in the Homathko River drainage west of major infestations in the Cariboo Region. Localized infestations persisted in mixed stands in the Pemberton area. The number of beetle-killed trees increased slightly to 250 in three areas in the eastern part of Manning Provincial Park following a four-year control program. Cruises in five infested stands in the Region from Manning Park to Birkenhead Lake averaged 22% of the trees (range 7-41%) currently attacked, indicated continuing infestations in 1986.

Lodgepole pine dwarf mistletoe

Arceuthobium americanum

Lodgepole pine dwarf mistletoe is widespread throughout the Province and has caused significant volume losses, particularly in the Cariboo Region. As part of a special study to determine the extent and incidence of mistletoe infection in regeneration lodgepole pine in stands susceptible to mountain pine beetle, 18 areas were surveyed from Gaspard Creek to Anahim Lake.

All areas were infected by dwarf mistletoe and 10 were lightly (less than 5% of the trees) infested by mountain pine beetle. Mistletoe infection ranged from light in 3 stands to moderate in 9 and severe in 6, based on a six class rating system. In 16 areas infection of more than 1 700, 12-year-old regeneration averaged 19%, (range 1-60%). Such a mistletoe infected understory should not be relied on for satisfactory regeneration.

Stem and branch diseases

Western gall rust, *Endocronartium harknessii*, and Atropellis canker, *Atropellis piniphila*, infections in lodgepole pine stands are widespread throughout British Columbia. Although not specifically surveyed for each year, some stands in which disease was noticeable are reported below. Perennial galls of *Endocronartium harknessii* infected most of the mature lodgepole pine at three sites on Vancouver Island. Stem galls killed up to 5% of the trees and some branch flagging occurred in the Port Alberni summit area. Mainly branch infections occurred in stands in Pacific Rim National Park and near Parksville.

Atropellis canker, *Atropellis piniphila*, killed 7% and infected 55% of the 60-year-old lodgepole pine in 10 plots at Pine Creek in the Telkwa River drainage in the Prince Rupert Region. Most of the infected trees had more than one stem infection and were less than 25 cm dbh. Near Dominic Lake in the Kamloops Region 80% of the 100-year-old lodgepole pine were infected by 1 to 8 stem cankers.

Needle diseases

Infection of lodgepole and white pines by native needle diseases in the Kamloops, Nelson and Prince George regions declined following successive years of severe infection and needle loss, but continued at high levels in ponderosa pine stands in the Kamloops Region.

At least half of the year-old ponderosa pine needles, on up to 90% (avg. 35%) of the trees in numerous 10 to 300 ha stands, were infected by *Elytroderma deformans* in the Kamloops Region from Lytton to Little Fort and east to Chase and between Oliver and Penticton.

Infection of year-old white pine needles by *Scirrhia pini* in a permanent study plot at Summit Lake in the West Kootenay declined by nearly 20% from 1984 levels. However, the effects of successive years of severe infection killed two trees near the plot and the lower third of the crowns of most pine in the plot. Similar declines in needle infection of lodgepole pine and some ponderosa pine stands occurred in part of the Kamloops Region and in the East Kootenay. In lodgepole pine provenance plantations at Red Rock in the Prince George Region, infection levels declined with 20% of all trees infected mainly by *Lophodermella concolor* and, to a lesser degree, by *S. pini*. Most of the older needles on mature lodgepole pine over 450 ha along Phinetta Creek west of Little Fort were severely infected and discolored by *L. concolor*. Half of the 1984 needles of 50% of the natural regeneration lodgepole pine at Little Qualicum Falls were infected by *L. concolor* and 30% of the infected 1983 needles were prematurely cast.

A pine needle sheathminer *Zelleria haimbachi*

Increased populations severely discolored up to 30% of the 1985 shoots on most of the regeneration lodgepole pine over more than 50 ha in the Fly Hills west of Salmon Arm in the Kamloops Region. Outbreaks, usually of two years duration, have periodically and severely defoliated up to 5400 ha of immature and mature pine in the Okanagan and North Thompson River Valleys.

Pine sawfly *Neodiprion* sp.

Moderate defoliation of older needles of lodgepole pine by increased sawfly populations affected patches of mature forest totalling about 100 ha, between Wire Cache and McMurphy in the North Thompson River Valley in the Kamloops Region. A previous outbreak in the area between 1976 and 1978 affected nearly 10 000 ha. At Brandywine Falls in the Vancouver Region, older needles on about 65% of the 20-year-old lodgepole pine in the Provincial Park were consumed by the sawfly, which is not a common pest of pines in this Region.

Pinewood nematode *Bursaphelenchus xylophilus*

In the third year of special surveys, there was no evidence of this nematode in 80 branch and stem samples collected mainly from symptomatic, dying trees throughout the province. However, native bacterial feeding or insect-associated *Bursaphelenchus*, *Aphelenchoides*, *Cryptaphelenchus* and *Acrobeles* were isolated from 11 lodgepole pine samples, 2 white spruce and single samples of both western white pine and alpine fir and from one adult *Monochamus* sp. woodborer, a nematode vector. These nematodes were in samples collected from all six forest regions.

Responsible for killing pine over large areas in Japan, the nematode was first recognized in the United States in 1979. Economically serious quarantine restrictions have been placed on lumber exports from nematode infested areas.

European pine shoot moth *Rhyacionia buoliana*

Pheromone-baited traps, placed on a trial basis in Victoria, Nanaimo, Comox and Kelowna, captured European pine shoot moths (avg. 16, range 0-66). Damage to native pines was not apparent, although exotic pines were infested and a population still apparently remains in the Okanagan Valley. The high variability among trap catches (0-66 male adults), due to location and population density, made comparisons of Canadian and American traps and lures difficult.

Spruce pests

Spruce beetles *Dendroctonus rufipennis* *D. punctatus*

For a third consecutive year the area of mature white and Engelmann spruce killed by spruce beetle declined. Although active in all regions, most of the 15 800 ha over which spruce beetle activity was mapped was in the Prince Rupert Region (Map 2). Salvage operations and host depletion were the major factors in the decline although early, below normal temperatures killed up to half the overwintering brood in some areas. More scattered tree mortality continued in the Prince George Region and parts of the Cariboo, Kamloops and Vancouver regions and in one stand on the Queen Charlotte Islands.

The area containing recently killed mature spruce in the Prince George Region declined to 4000 ha from 26 120 ha in 1984, (Table 2). Harvesting and reduced brood emergence from previously infested stands have been the major factors in the decline, particularly in the Bowron and McGregor river drainages. A further decline is expected in 1986.

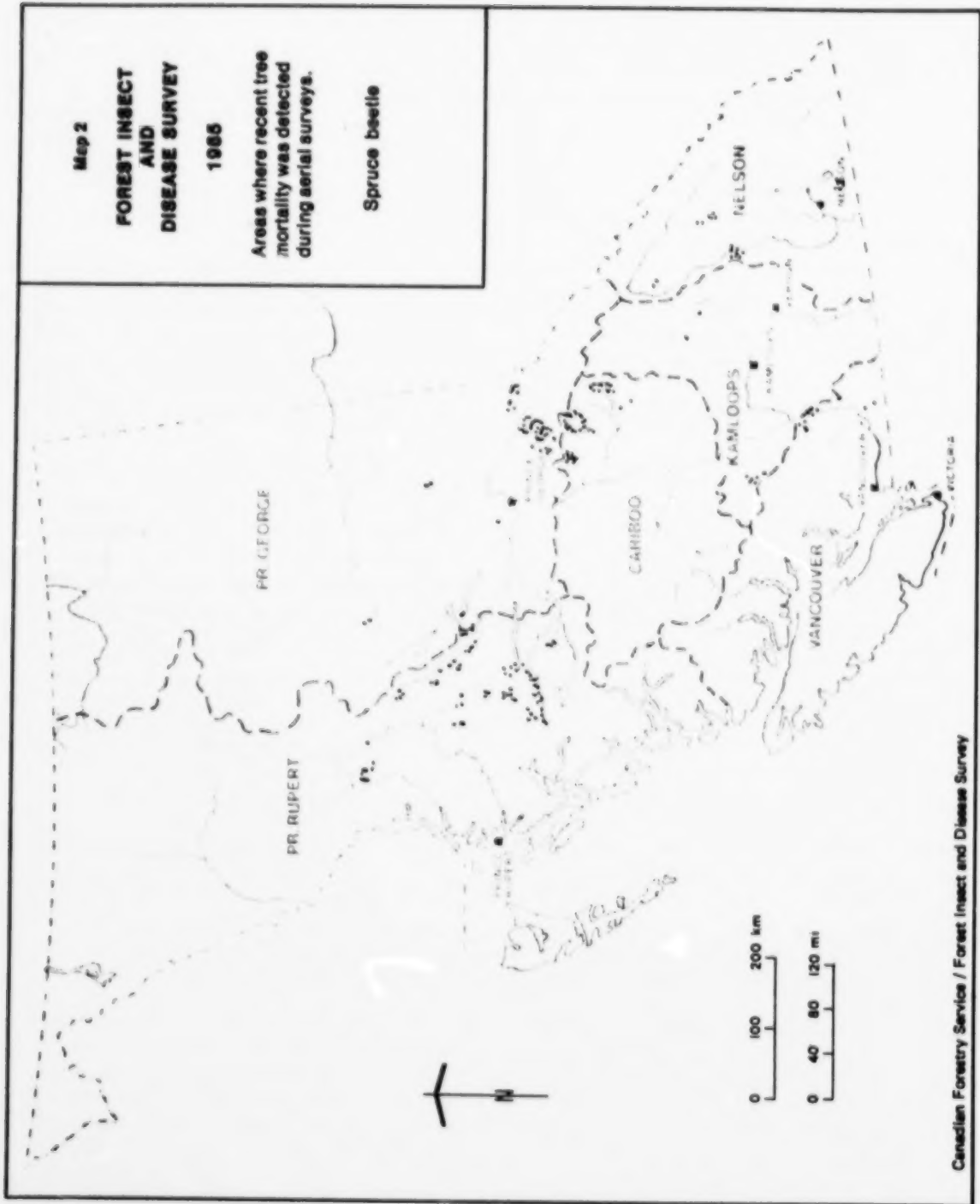
A similar decline occurred in the Prince Rupert Region down from 13 600 to 7400 ha in 1985. Most tree mortality is associated with previously beetle-infested areas in the eastern part of the Region from the Nass River Valley, south to Ootsa Lake. The decline is expected to continue.

Table 2. Number and area of spruce beetle infestations by provincial forest regions, based on recently killed trees observed during aerial surveys and limited ground observations, British Columbia, 1985

Region	No. of Infestations	Area (ha)	Volume Killed (000m ³)	Stands Cruised	Average % of Trees ^a				
					H	C	R	G	P
Cariboo	50	2500	35	0	—	—	—	—	—
Kamloops	20	1000	30	0	—	—	—	—	—
Nelson	45	570	19	0	—	—	—	—	—
Prince George	135	4000	78	0	—	—	—	—	—
Prince Rupert	120	7400 ^b	67	3	53	14	17	8	8
Vancouver	10	330	—	0	—	—	—	—	—
TOTAL	380	15 800	229	3	53	14	17	8	8

^a H = Healthy, C = Current, attacked in 1983-84, R = Red, attacked in 1982-83, G = Grey, attacked prior to 1982, P = Partial attack.

^b Estimates include data from B.C. Ministry of Forests.



In the Kamloops Region the areas of recently killed spruce covered 1000 ha, up from 700 ha in 1984. Infestations in Connel and Whitecap creeks (650 ha) and McGillivray creeks (350 ha) north of Anderson Lake continued. Spot infestations persisted in scattered areas east of Vernon, north of Chase and in the North Thompson and Upper Adams river drainages.

Only single, recently attacked mature spruce scattered over 75 ha were found near the southern boundary of Glacier National Park in the Nelson Region, down from 250 ha in 1984. Harvesting removed all previously infested and susceptible trees from adjacent stands. During October 1985 surveys, only very low numbers of adults were found in 1984 attacked trees and no current attack, down from 7% in 1984. The adult beetles should be absorbed by felled, windthrown and slash fire damaged trees scheduled for removal after the beetle flight in 1986. Elsewhere in the Nelson Region, isolated infestations declined overall to 495 ha, down from 3700 ha in 1984. These are all associated with previously active infestations in the Upper Bull River Valley in the East Kootenay and in the Upper Arrow Lake drainage in the West Kootenay.

After three years of beetle attacks in mature spruce between km 70 and km 83 on the Haines Road, between the Yukon and Alaska borders, there were no currently attacked trees evident in 1985. In 1983 about 300 accessible trees were removed or the bark was peeled from inaccessible trees to control the infestation. There was no evidence of *Polygraphus rufipennis*, a secondary beetle which in 1984 moderately infested previously felled and partially peeled trees.

Two-year-cycle broods at Phantom Creek on Graham Island, in groups of 2 to 5 stressed mature Sitka spruce over about 20 ha, remain a potential threat to adjacent overmature trees. Spruce windthrow in the predominantly hemlock-cedar forest will likely absorb but sustain the low beetle population for several years.

Allegheny spruce beetle, *Dendroctonus punctatus* was collected for the first time in British Columbia in stressed mature spruce west of Mackenzie in the Prince George Region. Very low populations of this less aggressive beetle infested mature spruce in an active logging area in the La Biche River Valley in southeastern Yukon, the

first record of damage by the beetle in the Territory in more than 25 years.

The overall decline trend is expected to continue in 1986, although increases will occur in some areas. In three cruise strips in the Prince Rupert Region current attack averaged 14% (range 7-26%), up from 8% in 1984. This occurred in small patches where beetle activity has occurred since the early 1980's and were not logged, or in localized mature stands in the Nilkitkwa Lake area. There was no current attack in and near Glacier National Park in the Nelson Region; only a few two-year-cycle adults were evident in a small number of 1984 attacked trees.

Two-year cycle broods in 1984 blowdown in parts of the Cariboo, Prince George and Prince Rupert regions could result in increased attacks and tree mortality in 1986. Populations which infested recent windfall in 1984 east of Smithers from Babine Lake south to Ootsa Lake should emerge in 1986, and could attack standing mature spruce. The number of adult beetles in 1000 cm² of bark in blowdown trees at eight sites ranged from 0-200. Mature spruce windthrown in mid-late summer this year in areas east of Prince George and in the eastern part of the Prince Rupert Region could contribute to population increases in 1987.

Spruce aphid *Elatobium abietinum*

Moderate and severe defoliation and some tree mortality of shoreline Sitka spruce caused by spruce aphid occurred in scattered east coastal areas of Moresby and Graham Islands on the Queen Charlotte Islands, where severe defoliation has occurred periodically since 1961. Populations in mainland coastal areas between Prince Rupert and Port Edward and on Vancouver Island declined. Following periodic years of severe defoliation, mortality of Sitka spruce in a natural stand near Miller Creek on Graham Island ranged from 9% of the larger trees (61+ cm dbh), to 59% of the smaller diameter trees (less than 50 cm dbh). In a nearby permanent study area 67% of the severely defoliated spruce (avg. 62 cm dbh), preselected in 1982, were killed. In the same general area, aphid feeding destroyed all the 1984 and older needles on 65% of the eight-year-old planted spruce and about half

the needles on the balance. Feeding on current year tips occurred on less than 15% of the trees.

The population decline in the Prince Rupert area and on Vancouver Island was attributed to unseasonably cold weather in October 1984.

Northern spruce engraver

Ips perturbatus

In a second year of outbreak, the upper crowns of about 4000 mature spruce were killed by the

engraver beetle. Infested trees were scattered singly and in groups of 1 to 10 throughout stands east of Prince George. Recently killed tops up to 20 m long were most common in the Torpy River Valley but less numerous in the McGregor, Bowron and Parsnip river valleys.

Light engraver beetle populations, including *Ips perturbatus* and *I. tridens* were common in slash in adjacent recently harvested stands. A study of the biology, parasitoids and predators of *I. perturbatus* is in progress.

Douglas-fir pests

Western spruce budworm

Choristoneura occidentalis

The area of mature and immature Douglas-fir forests in the Kamloops, Cariboo and Nelson regions moderately and severely defoliated by the budworm in 1985 expanded threefold to 214 000 ha (Map 3).

A major expansion to 180 400 ha of mainly severe defoliation occurred in the Kamloops Region from north of Savona east to Adams Lake and in the North Thompson River drainage from Heffley Creek to near Little Fort. Light and moderate defoliation occurred for the first time since 1976 along the north shore of Anderson and Seton lakes, in the Bridge River Valley and along the south side of Carpenter Lake in the Lillooet TSA and in the Okanagan TSA southwest of Oliver and east of Osoyoos.

A similar expansion occurred in the Cariboo Region where the area of moderately or severely defoliated Douglas-fir increased to 33 400 ha from 18 800 ha in 1984. The expansion was mainly north of Clinton to 61 Mile Creek, east along the Bonaparte River Valley and west to near Kelly Lake. Stands on Hart Ridge and in the Loon Lake area were moderately defoliated for the seventh and fourth consecutive years, respectively.

In the Nelson Region moderate defoliation of current year's foliage of Douglas-fir occurred over 50 ha near Johnston Creek Provincial Park east of Bridesville, the eighth successive year of defoliation.

Vancouver Region populations remain low in previously infested Douglas-fir stands from Manning Park to Pemberton including the Fraser Canyon.

Mortality of understory regeneration in three stands southeast of Clinton, defoliated by the budworm for 4 to 7 consecutive years was highly variable (0, 8 and 95%). In a preliminary assessment with the Damage Appraisal group, surviving trees had lost from 2 to 4 years height growth.

Based on large moth flights in early to mid-July and high numbers of eggs (avg. 291, range 27 to 970/10 m² foliage)¹ in samples from or adjacent to 27 currently infested stands, defoliation is expected to continue and expand in 1986. Severe defoliation is forecast for 60% of the sites, mainly in the Kamloops Region and moderate defoliation at all but one of the balance.

Parasitism of early and late instar larvae occurred

¹ 1-50 = light; 51-150 = moderate; 151+ = severe defoliation

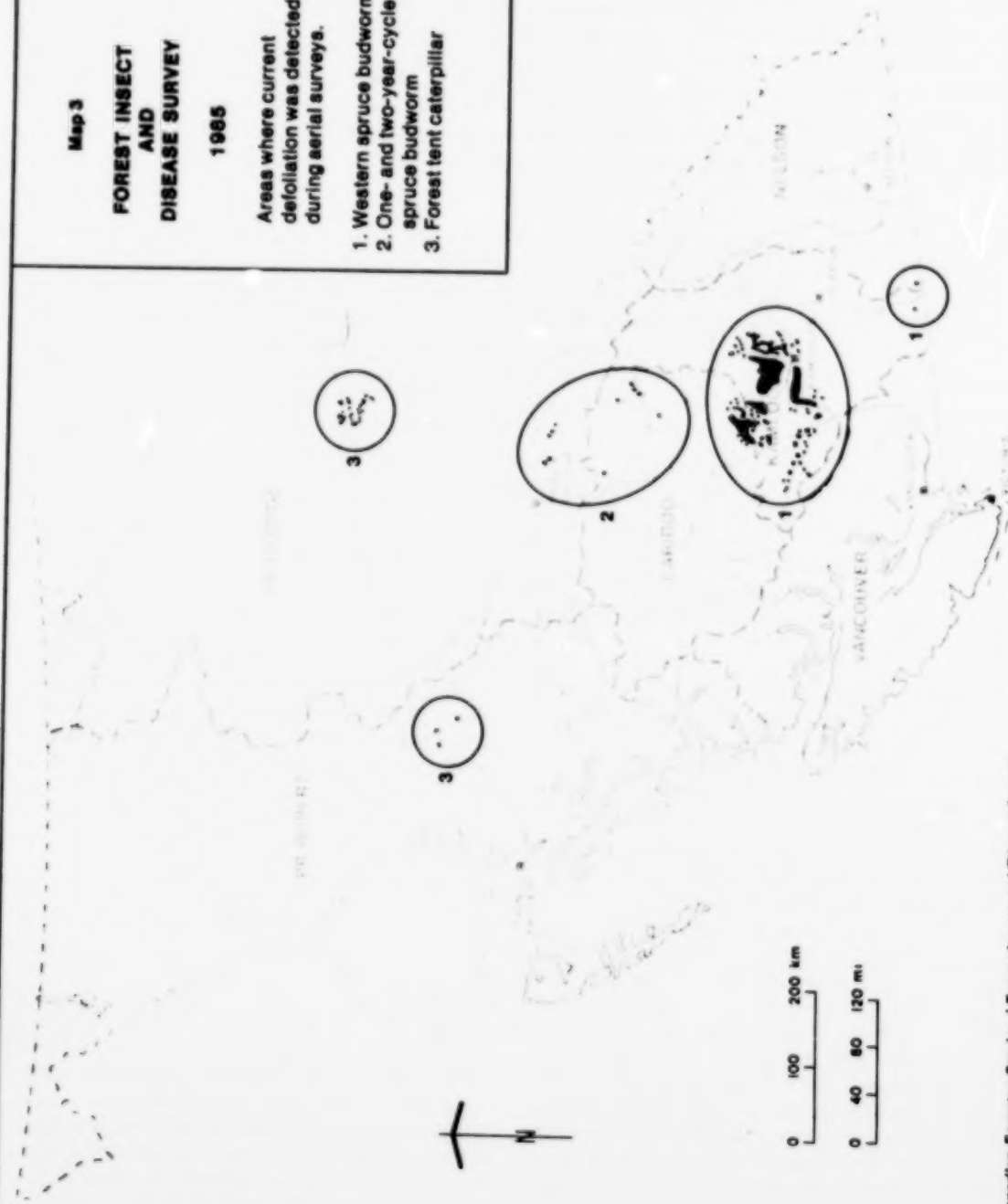
Map 3

FOREST INSECT AND DISEASE SURVEY

1985

Areas where current
defoliation was detected
during aerial surveys.

1. Western spruce budworm
2. One- and two-year-cycle
spruce budworm
3. Forest tent caterpillar



at only 3 of 18 sites in the Kamloops and Cariboo regions and averaged 11% (range 7-18%), too low to effectively reduce populations in 1986.

Pheromone-baited sticky traps were not used in 1985 after analysis indicated that traps saturated and counts were inconclusive and not correlated with subsequent populations or damage. More effective traps will be evaluated and data gathered for calibration and interpretation purposes.

Douglas-fir tussock moth

Orgyia pseudotsugata

After a major population collapse in 1984, only four pockets of Douglas-fir west of Kamloops totalling 70 ha were severely defoliated in 1985. There was no defoliation in previously defoliated stands in the Kamloops, Cariboo, Nelson and Vancouver regions. The high incidence of naturally occurring nuclear polyhedrosis virus and Diptera parasites were major factors in the collapse. As only two egg masses were found in 1985 defoliated stands and only 5 male moths were trapped in 380 widely distributed pheromone traps, major areas of defoliation are not expected next year.

The effects of consecutive years of defoliation by Douglas-fir tussock moth were examined in a study area south of Clinton in the Cariboo Region, where populations collapsed in 1983. Of 63 plot trees severely defoliated in 1982-83, about half retained 20% or less of their needles in 1984. By 1985, although 11% of the trees were dead, tree recovery was evident in the surviving trees; more than half the trees had regained 30-80% of their foliage complement. Increment and height growth loss is currently being evaluated in cooperation with the Damage Appraisal group.

There was little additional tree mortality in stands mainly in the Kamloops Region where the 3 year outbreak had covered 23 500 ha and conspicuous tree mortality had been mapped over 5100 ha in 1984. Douglas-fir beetle attacks in the stands declined. In a cooperative CFS, Damage Appraisal (R. Alfaro)-BCMF Protection Branch study, 61 Douglas-fir stands in the Kamloops Region were examined annually for defoliation, mortality and top-kill caused by the 1982-83 outbreak; a detailed report is being prepared. On

average, mature stands defoliated 1 year sustained 10% mortality while in immature stands 38% of the trees died. With 2 or 3 years defoliation, mortality amounted to 55 and 66% of the trees in mature and immature stands, respectively. Most of these trees (80%) died during the infestation, but 11% died in 1984 and 9% in 1985. Of the surviving trees, 17% of the mature and 2% of the immature were top-killed after 1 to 3 years of defoliation.

Douglas-fir beetle

Dendroctonus pseudotsugae

Mortality of mature, mainly predisposed Douglas-fir trees continued in pockets totalling 1 725 ha in parts of the Cariboo, Kamloops, Prince George and Vancouver regions.

Light, scattered mortality occurred in the Cariboo Region over 1475 ha mostly in 3 ha to 60 ha pockets in 20 Supply Blocks in 3 Timber Supply Areas. The largest areas of mortality occurred in the Springhouse, Gaspard and China supply blocks over 1225 ha.

Pockets of 2 to 5 Douglas-fir trees were killed by the beetle in stands over 60 ha between Cache Creek and Pritchard in the Kamloops Region. The stands were severely defoliated by Douglas-fir tussock moth in 1982-83. However, beetle progeny were not produced and there was no evidence of current attack in those stands or in previous tussock moth defoliated stands west of Keremeos.

In the Prince George Region, small groups of veteran Douglas-fir were killed at scattered locations along the Blackwater River Valley, the fourth consecutive year of tree mortality in the area, and northeast of Prince George.

Light attacks in pockets of recent blowdown of mature Douglas-fir occurred at scattered locations totalling 156 ha in the Skagit River in the Vancouver Region. Of the 25 pockets of 2-10 recently killed mature Douglas-fir in the North Bend area of the Fraser Canyon, 38% were killed by the beetle and 62% by *Phellinus weirii*. Current attacks in windthrown trees infected with *P. weirii* have occurred annually for many years.

Western false hemlock looper

Nepytia freemani

Increased populations caused light to moderate defoliation of upper crowns of immature Douglas-fir in two pockets, totalling 50 ha, in a Christmas tree production area north of Invermere in the Nelson Region. The increase followed a population decline in the Windermere Valley in 1984 after 100 ha were defoliated in 1983.

The extremely high incidence of infection of larvae (98%) in the defoliated areas by a naturally occurring nuclear polyhedrosis virus, and the very low numbers of eggs per sample (avg. 2) indicate a population collapse. Defoliation is not expected in 1986 in those areas defoliated in 1985.

Needle diseases

Infection of Douglas-fir needles increased in natural stands in the Cariboo Region and on Vancouver Island but declined in the East Kootenay. Most year-old needles on most Douglas-fir in the Clinton area were more severely infected by *Rhabdocline* needle disease, *Rhabdocline pseudosugae*, than in 1984. East of the Kootenay River in the Nelson Region, *Rhabdocline* infections declined with only 10% to 30% of the year-old needles discolored on 25% of the trees in stands up to 150 ha. In the Cameron River Valley on Vancouver Island up to 60% of last year's needles were prematurely cast from roadside trees severely infected by Swiss needle cast, *Phaeocryptopus gaeumannii*.

True fir pests

Budworms

Choristoneura spp.

Populations in previously defoliated stands in central and northern British Columbia declined overall but increased in parts of the Cariboo and Prince George regions.

One- and two-year cycle budworms, *C. orae* and *C. biennis*, lightly and moderately defoliated current year's foliage of alpine fir and spruce over 6550 ha in eastern parts of the Cariboo and Prince George regions (Map 3), compared with 12 700 ha in 1984. In the Willow River and Big Valley Creek drainages in the Cariboo Region damage to 1985 buds by early instar larval feeding was severe over 3700 ha where 200 ha were lightly defoliated by late instar larvae in 1984. Light defoliation occurred for the first time since 1979 over 2250 ha near Quesnel and Horsefly lakes. At Everett Creek east of Prince George, 10% of the new buds were infested over 200 ha. Similar damage occurred for the first time to alpine fir above 1100 m elevation in an adjacent valley. In the Bowron River Valley less than 1% of the 1985

buds of understory alpine fir on the east side of the valley were infested. However, on the west side up to 50% of the buds of both fir and spruce over 200 ha were destroyed by early instar two-year-cycle budworm.

Endemic populations continued in isolated higher elevation fir-spruce stands in Bugaboo Creek in the Nelson Region, but not in the north fork of the White River Valley.

Budworm populations remain low in previously active infestations in the Kispiox, Skeena and Nass river drainages in the Prince Rupert Region. In some of these stands, severely defoliated between 1981 and 1983, top and branch dieback was evident on 15% of the understory alpine fir and 5% of the spruce.

Populations of eastern spruce budworm, *Choristoneura fumiferana*, in the Liard River Valley declined significantly after moderately defoliating alpine fir and spruce over 7300 ha in 1984. Light defoliation of 1985 foliage occurred along the Fort Nelson River Valley and in the La Biche

River Valley in the southeastern Yukon Territory. A naturally occurring fungus, *Beauveria bassiana*, infected dead larvae from the La Biche River area and is the first record of the fungus in the Yukon.

Based on the presence of early instar larvae in parts of the Prince George and Cariboo regions, defoliation is expected to be light to moderate in those areas in 1986, when larvae mature.

Balsam woolly aphid

Adelges piceae

Small numbers of aphids, but no damage, were found near Parksville on Vancouver Island. This represents an extension beyond the 1976 infestation zone but is still inside the quarantine zone in southwestern British Columbia. Aphids and damage were found within the zone on *Abies amabilis* seed orchard stock near Victoria. There was no evidence of the aphid or damage on stock at three other seed orchards, one nursery or in three natural stands adjacent to mills where *Abies* spp. logs were shipped for processing elsewhere on the Island. *A. amabilis* and *A. grandis* stock at 12 nurseries and in adjacent stands in the central Fraser Valley within the quarantine zone were also aphid-free, as were seven natural grand and alpine fir stands along the International border in the Nelson Region.

A Budmoth

Zeiraphera sp.

The budmoth, which lightly defoliated upper crowns and leaders of most age classes of *amabilis* fir in mixed stands near Kelsey Bay, Schoen Lake and Northwest Bay on Vancouver Island in 1984, declined. Only 30% defoliation and fewer than 10 larvae were found in stands near Port Alberni. Laterals and leaders in the upper crowns of immature fir were lightly defoliated in the Salmon and Memekay river drainages west of Campbell River.

Western balsam bark beetle

Dryocoetes confusus

Significant volumes of mature alpine fir in high elevation stands in Interior Forest Regions, particularly the Prince George and Nelson regions, have been killed by the beetle-fungus complex since infestations were first recorded in 1931. In 1985, most of the province-wide 45 000 ha containing mature alpine fir recently killed by the beetle and an associated fungus, *Ceratocystis dryocoetidis*, occurred in the Prince Rupert Region. Infested areas covered 37 000 ha (up 35% from 1984), mainly in the Bulkley and Morice TSAs in the eastern part of the Prince Rupert Region, 4500 ha in the Prince George Region and ranged from 30 to 2500 ha in the Cariboo, Kamloops, Nelson and Vancouver regions.

Hemlock pests

Western blackheaded budworm

Acleris gloverana

In the second year of this outbreak, blackheaded budworm defoliated mostly old growth western hemlock and some amabilis fir and Douglas-fir over 45 600 ha in five forest regions (Map 4), up from 19 000 ha in 1984. The most extensive feeding was 28 600 ha of mainly moderate defoliation on mixed aged stands in numerous southeast coastal areas of the Queen Charlotte Islands. Other areas included 2150 ha west of Harrison Lake in the Vancouver Region, 2200 ha along coastal inlets of the Prince Rupert Region, 9400 ha in the interior wet belt near Quesnel Lake in the Cariboo Region, 3100 ha from Mabel Lake to Wells Gray Provincial Park in the Kamloops Region, and 150 ha near Revelstoke in the Nelson Region.

Top-kill and mortality can usually be expected even after one year of severe defoliation. During the 1973-74 infestation on the Queen Charlotte Islands, 67% of the immature and 33% of the mature trees in study plots died after two years of severe defoliation. Significant tree mortality was not recorded in the interior and south coast infestations.

Egg samples from 21 defoliated stands in five regions indicate increasing populations and severe defoliation on the Queen Charlotte Islands, and near Kitimat, but low populations and trace or light defoliation in the Cariboo, Kamloops, Nelson and Vancouver regions. The most severe defoliation is expected at east coastal areas of Moresby Island from Sewell Inlet south to Kung-hit Island, and along coastal inlets near Kitimat. Eggs per sample averaged 118, (60 or more eggs per branch sample indicates severe defoliation).

Western hemlock looper

Lambdina f. lugubrosa

After lightly and moderately defoliating mostly old-growth western hemlock and some western red cedar over 13 350 ha in 40 separate infestations in eastern areas of the Kamloops and Cariboo

regions in 1984, populations failed to hatch from overwintering eggs. The decline was due largely to infection of up to 38% of 1984 larval populations by a nuclear polyhedrosis virus, up to 51% larval parasitism by Diptera and Hymenoptera and parasitism of overwintering eggs by the wasp *Telenomus* sp.

About 3% of the trees were killed and top-kill of 2 to 3 m was evident on up to 22% of old growth hemlock in parts of the Cariboo Region and in pockets totalling 450 ha in the Nelson Region, where one to three years of moderate and severe defoliation occurred before populations collapsed.

A hemlock sawfly

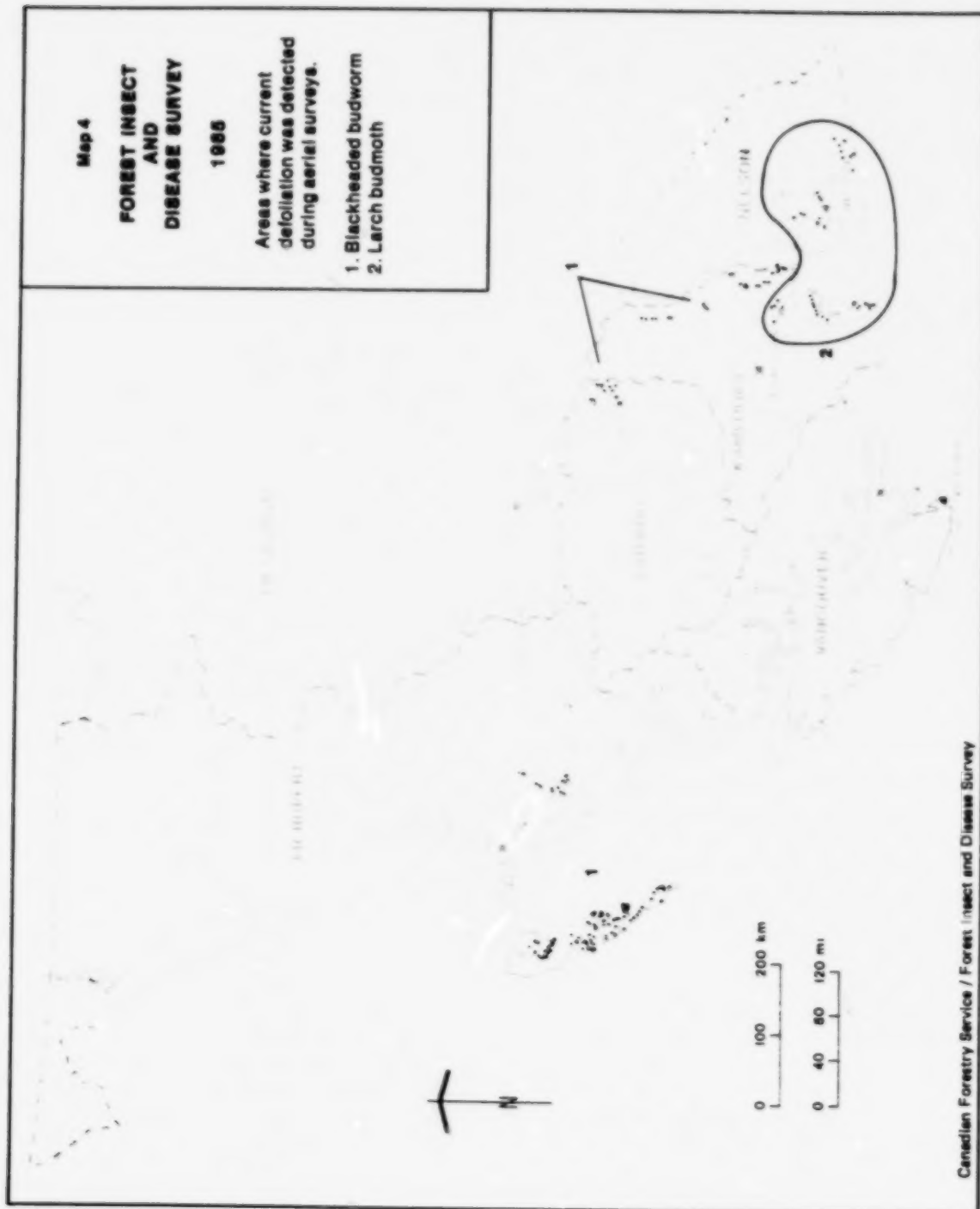
Neodiprion sp.

Immature and some mature western hemlock were lightly defoliated by increased populations over 500 ha in Doré Creek near McBride in the Prince George Region. Populations have increased annually since 1983 and are expected to be active in 1986. Western hemlock and alpine fir were severely defoliated along 5 km of the Boundary Creek access road near the B.C.-Idaho border in the Nelson Region. This is the first record of hemlock defoliation by sawflies south of the Upper Arrow Lakes-Revelstoke area.

Terminal crook disease

Colletotrichum acutatum

Inspections of western hemlock seedlings for the pathogen in four plantations near Northwest Bay were negative for the fourth consecutive year, indicating that the pathogen has not become established. The outplanted stock was examined annually following the discovery of the introduced disease on hemlock seedlings in a Lower Mainland nursery in 1981. Reddened foliage on 33 of the 1981 planted hemlock was caused by light infections of a shoot and leaf fungus, *Sclerophoma* sp.



Larch pests

Larch casebearer *Coleophora laricella*

Defoliation of western larch continued throughout much of the southern part of the host range in southeastern B.C. but was less severe than in 1984, particularly from Creston to Elko where about 40 000 ha were severely defoliated last year. Defoliation was generally very light from Cranbrook to Yahk and near Fruitvale, and light or moderate near Canal Flats, around Cranbrook south to the International border and at Anarchist Mountain. Light defoliation was evident for the first time at Wilson Creek near Slokan Lake which is relatively isolated from casebearer populations elsewhere in the West Kootenay. At 11 permanent sites from Anarchist Mountain to Elko defoliation averaged 8% (range 0-35%).

At two permanent sites in the Kamloops Region at Shuttleworth Creek east of Okanagan Falls and near Cherryville there was no defoliation. However, near Vernon about 40% of the trees over 100 ha were lightly defoliated (less than 5%).

In the West Kootenay and adjacent parts of the Kamloops Region populations remain low, due in part to periodic parasite releases since 1969. The incidence of parasitism throughout infested larch stands was less than 4%, similar to 1984. As part of a continuing biological control program, more than 3500 male and female adult larval parasites, *Chrysocharis laricellae* and 29 *Agathis pumila* were introduced from Austria and Switzerland. They were released from mid-June to early August in six infested stands in the Nelson Region near Cranbrook, Wycliffe, Elko and at Wilson Creek near Nakusp.

To monitor casebearer populations and their spread beyond the known distribution limits, pheromone traps were set out for the second consecutive year at 16 locations in the Nelson and Kamloops regions. An average of 69 moths per trap (range 1-128) were caught at six sites, 15 to 50 km from known casebearer populations. In 1984, 16 locations averaged 89 moths. The data indicate a northward migration of the casebearer within its host range, particularly in the West

Kootenay. None were caught near Mara Lake 60 km east of populations near Vernon, where an average of 235 moths per trap was recorded.

Negligible to very light defoliation of western larch stands in the Nelson and Kamloops region is expected to continue in 1986. From Anarchist Mountain east to Jaffray overwintering larvae per 100 fascicles averaged only 12 (range 1-40) at 11 permanent sample sites.

Larch sawfly *Pristiphora erichsonii*

There was no evidence of populations or continued defoliation of tamarack earlier this year near Watson Lake in the Yukon. However, in La Biche River Valley healthy cocoons were collected from duff in August indicating populations could continue in 1986 in the Yukon.

Western, eastern, Japanese and Polish larch in six 20 to 30-year-old plantations in the UBC Research Forest near Haney were defoliated. Populations are expected to cause some defoliation in 1986 based on the numbers of pupae in duff samples collected for viability and parasitoid assessments.

Following three years of defoliation of western larch stands near Kimberley, Skookumchuck and in the Elk River Valley in the Nelson Region, sawfly populations declined to endemic levels. The decline following defoliation over 3000 ha in 1984 was due to natural parasitism of larvae and predation of overwintering prepupae in cocoons. A pathogen, *Beauveria bassiana*, infected a small number of cocoons in the Elk River Valley.

Larch budmoth *Zeiraphera improbana*

About 14 800 ha of scattered western larch stands above 1200 m elevation in the western part of the host range in the Nelson and Kamloops regions were moderately or severely defo-

liated by the budmoth (Map 4), up from 1100 ha in 1984.

Most of the 5800 ha in the Nelson Region were from Yahk to Salmo, along the west arm of Kootenay Lake to west of Castlegar and in the Slokan River Valley.

In the Kamloops Region about 9000 ha of mature larch were for the first time moderately or severely defoliated by the budmoth in 52 widely scattered areas from Anarchist Mountain to Lumby.

Needle diseases

Infection of western larch foliage by larch needle diseases, *Hypodermella laricis* and *Meria laricis*, throughout the host range declined significantly. In the East Kootenay infection of most previously

affected stands by *H. laricis* generally dropped to 10% from 80%, with only localized areas of 10-200 ha with up to 40% of the needles infected; a similar decline occurred in the West Kootenay. In the West Kootenay *M. laricis* was most prevalent with 15% of the needles on about half the trees affected from Ymir to Upper Arrow Lake. There was little current infection in adjacent areas of the Kamloops Region.

European larch canker

Lachnellula willkommii

Surveys for the canker, potentially damaging to all age classes of western, alpine and eastern larch, were negative for the fifth consecutive year. Currently, North American distribution is limited to New Brunswick, Nova Scotia and some eastern States.

Multiple host pests

Black army cutworm

Actebia fennica

Seedling mortality, bud damage and defoliation of herbaceous ground cover caused by the cutworm occurred for the fourth consecutive year in the Prince Rupert Region and in the Cariboo Region for the second year. Some planting programs were delayed. Populations in the Prince George Region declined for the second consecutive year and none were reported in the Kamloops Region.

Populations were more numerous and widespread in the Prince Rupert Region. Spruce and some pine seedlings at 10 of 31 recently burned planting sites were affected in the Morice, Bulkley and Lakes TSAs. Mortality of about 120 000 seedlings planted in 1985 occurred in numerous scattered 1-ha to 5-ha areas in the Swiss Fire and Poplar Lake areas south of Houston, in Harold Price Creek at Walcott and Telkwa River. Light

to severe cutworm feeding occurred at Taltzen, Chapman Lake and Smithers Landing. Bud mortality on 1984 planted seedlings at Walcott and Betty Lake was light. At many sites, up to 80% of the herbaceous material was defoliated. Pupal sampling suggests static to increasing populations in 1986 (800 cm² duff samples contained an average of 2.5 to 30 healthy pupae per site). As very few areas in the eastern part of the Prince Rupert Region, where the cutworm is currently active, were burned in 1984, populations are expected to concentrate in these few burns or remain in currently infested 1983 burned sites.

Douglas-fir and some spruce and pine seedlings were severely defoliated and buds were killed at five recently planted sites in the Quesnel Lakes area in the Cariboo Region. Bud-kill of Douglas-fir averaged 55% (range 4 to 90%) near Cedar, Sellars and Rollie creeks and Boswell and Ken Ingram lakes, and 64% (range 30-99%) of the seedlings were severely defoliated. Planting pro-

grams were delayed at Rollie Creek.

High numbers of larvae killed about 2000 lodgepole pine seedlings near Indianpoint lakes in the Prince George Region, but caused very little damage to either seedlings or herbaceous growth at Chief Lake north of Prince George and two sites in the Bowron and Willow river drainages. Low and moderate numbers of larvae occurred in three sites in the Canoe Arm south of Valemount and near Tete Jaune Cache, but seedlings were not damaged. Increased numbers of a hornworm, *Hyles gallii intermedia*, in or adjacent to active cutworm populations in the Prince George Region defoliated herbaceous ground cover but did not damage seedlings.

The average number of moths in 156 baited sticky traps at 71 recently burned sites where cutworm was or is potentially active in three regions averaged 14, up slightly from 10 in 1984. However, in 77 non-sticky bucket traps used extensively for the first time in 17 active cutworm areas in the eastern part of the Prince Rupert Region, the traps attracted an average of 745 adults per trap (range 78-1400). The highest number of adults were in the Taltapin Lake area in the Lakes TSA, and 1300 adults were common in traps in Harold Price Creek and Turkelson River Valley in the Bulkley TSA. The highest number in sticky traps, 46, was in newly infested burned and planted sites near Shiko Lake near Horsefly in the Cariboo Region.

Trap data and the number of pupae indicate continuing populations, with the potential for damage to conifer seedlings ranging from light to severe in or near recently infested sites in the Prince Rupert, Prince George and Cariboo regions. A similar potential exists, based on historical evidence, in some of the 240 000 ha burned by wild fires in 1985, if scheduled for replanting in May-June.

Parasites, virus, predation, environmental factors and preferential feeding on herbaceous vegetation have reduced the impact of previous infestations. Cutworm larvae in infested sites near Bear Lake, Valemount, the south end of the Bowron River drainage in the Prince George Region and the Swiss Fire south of Telkwa in the Prince Rupert Region, were parasitized by small numbers of Tachinid flies, *Nowickia latigena*, *N. tahoensis* and *Mericia ampelus* and Ichneumonid

parasitic wasps, *Erigorgus* sp. and *Eutanyacra* sp. There was no evidence of nuclear polyhedrosis virus.

Root, butt and stem rots

Widespread mortality of cedar, Douglas-fir and spruce occurs annually throughout the province caused by root, butt and stem rots including *Fomes pinicola*, *Poria subacida*, *Phellinus weirii* and *Polyporus tomentosus*.

Butt rot infection of old growth western red cedar caused by *Fomes pinicola* and *Poria subacida* is widespread in the Likely and Horsefly areas of the Cariboo Region. An estimated 60% of the heartwood has decayed in most trees of 45-75 cm dbh and dead tops ranged from 10 to 15 m in length. Pockets of infected standing and wind-thrown mature Douglas-fir at widely scattered areas in the Fraser Canyon south of Boston Bar and in the Skagit River Valley infected by *Phellinus weirii* were attacked by Douglas-fir bark beetle.

A white pocket root and butt rot, *Polyporus tomentosus*, infected about 65% of the semi-mature spruce near Mt. Robson Provincial Park in the Prince George Region; 80% of the mature spruce in a stand in Stephanie Creek in the Bowron River drainage; and mature spruce in the Torpy River Valley infested with the engraver beetle, *Ips perturbatus*.

A conifer seedling weevil

Steremnius carinatus

The weevil killed up to 9% of the seedlings in twelve 1985 plantations on Vancouver Island. Mortality was most severe in a 20 ha unburned plantation at Quatchka Creek (Gold River) but also occurred in many other areas including Sarita, Mt. Washington, Kelsey Bay, Woss and Holberg. Within plantations, mortality varied from 0 to 9% averaging 4%; partial girdling damage was from 0 to 12% averaging 6%. Amabilis fir were most severely affected with 40% of the 1-0 plugs killed in one mixed plantation at Tsitika River north of Woss. About 6% of the other seedlings, including Douglas-fir, western hemlock, western red cedar, Sitka spruce and

grand fir were killed or partially girdled at the root collar.

Economically significant losses, increased reforestation and the variety of species now planted have increased interest in this weevil which was first recorded as a plantation pest in 1961.

Snow mould fungi

Phacidium sp.

Snow mould fungi, not commonly found on out-planted conifer seedlings, killed western larch, and moderately infected western white pine and Douglas-fir seedlings in two areas of the Nelson Region.

About 16% of the western larch seedlings planted in 1982 in research study plots near Grand Forks were killed by a snow blight, *Phacidium sherwoodiae*, which had not previously been reported on western larch in British Columbia. A small number of Douglas-fir and western white pine seedlings at two sites near Revelstoke were moderately infected by *Apostrasseria lunata*. This was previously found on necrotic primary needles of cold stored western larch seedlings and on young Corsican pine, *Pinus nigra* var. *poiretiana*, at the UBC Research Forest. Brown felt blight, *Herpotrichia juniperi*, moderately infected 10% of the Douglas-fir saplings in a mixed plantation near Northwest Bay on Vancouver Island.

Pests of young stands

Increased emphasis on pests of young stands identified several important insects and diseases in numerous stands in all six regions of the province.

Between 2 and 20% of the immature lodgepole pine were killed by Warren's root collar weevil, *Hylobius warreni*, over areas up to 50 ha in the Kamloops Region, near Allen Lake in the White River drainage in the Nelson Region and in the Salmon and Suskwa river valleys in the Prince Rupert Region. In the Prince Rupert Region, Atropellis canker, *Atropellis piniphila*, infected 6% of the young lodgepole pine in a plantation in the Suskwa River drainage. In the Kamloops Region, 80% of the immature (and some mature) lodgepole pine over 20 ha in the Jamieson Creek

drainage were infected by *A. piniphila* and dwarf mistletoe, *Arceuthobium americanum*. Western gall rust, *Endocronartium harknessii*, stem infections killed 6% of the young pine and caused stem breakage of 17% of the infected trees in Manning Park in the Vancouver Region.

Stem and branch infections by rusts were common in young pine stands between Elko and Yahk and in Perry Creek near Kimberley. A blister rust, *Cronartium comandrae*, killed 10% and infected 65% of the regeneration lodgepole pine over about 5 ha along Lodi Lake Road south of Prince George and 2% of the pine were infected in the Nilkitkwa Lake area in the Prince Rupert Region. Stalactiform blister rust, *Cronartium coleosporioides*, was found on Scots pine, *Pinus sylvestris*, in B.C. in a plantation west of Andrews Bay on Ootsa Lake in the Prince Rupert Region. Infection of 22-year-old planted spruce in the Telkwa River Valley by a root and butt rot, *Polyporus tomentosus*, was 11%.

As part of a test of disease resistance, 13 sites in 6 areas of the Prince George Region and Yukon Territory, to be planted with second generation Swedish lodgepole pine in 1986, were surveyed for native pathogens. Pathogens potentially damaging to lodgepole pine occurred at varying levels in most sites and included lodgepole pine dwarf mistletoe, *Arceuthobium americanum*, near Mackenzie and Fort St. James and western gall rust, *Endocronartium harknessii*, near Mackenzie, Fort St. John, Whitehorse and Watson Lake. Other damaging pests included rodents, probably snowshoe hares, which debarked about 25% of the regeneration pine in a site near Whitehorse. A pitch twig moth, *Petrova* sp., was common in stands near Watson Lake and Whitehorse. A site near Fort Nelson was unsuitable for planting for test purposes because of the absence of lodgepole pine.

Rhizina root rot, *Rhizina undulata*, killed about half the Douglas-fir and western white pine in a 25-ha site planted in 1984 east of Revelstoke. Seedling mortality caused by this fungus has occurred periodically in 'hot' burned sites from north of Terrace to Golden and on Vancouver Island.

About 21% of the ten-year-old Douglas-fir were killed by Armillaria root rot, *Armillaria* sp., in a 45 ha plantation at Begbie Creek south of Revel-

stoke. Root rot centers across the plantation contained 2 to 6 recently killed trees.

Seed orchard pests

In the 12 coastal and nine interior seed orchards surveyed in 1985, significant pests included: Swiss needle cast, *Phaeocryptopus gaeumannii*, common and light to severe in 8 orchards; Meria needle disease, *Meria* sp., lightly infected (avg. 6%), the foliage of Douglas-fir in 3 seed orchards on Vancouver Island from Saanich to Campbell River. The fungus, found for the first time on Douglas-fir last year infected 10% of the trees in seed orchards at Saanich, Koksilah and Campbell River and in two natural stands; Balsam woolly aphid, *Adelges piceae*, occurred on twigs of 4% of the amabilis fir in one orchard within the known infestation and quarantine zone. Spruce aphid, *Elatobium abietinum*, caused light defoliation of older needles in 5 seed orchards. Spruce gall aphid, *Adelges cooleyii* was common in 10 orchards. Western budworm, *Choristoneura occidentalis* lightly defoliated young stock in a Kamloops orchard which was adjacent to severely defoliated mature stands.

Cone and seed pests

Cone crops, although generally light, were slightly better than in 1984. Overall, cone and seed pests occurred to varying degrees in 80% of the 74 cone bearing stands examined province-wide. Major pests included Douglas-fir cone moth, *Barbara colfaxiana*, which infested up to 82% of the cones in parts of the Nelson Region. Spruce cone maggot, *Delia anthracina*, and spruce seed moth, *Cydia strobilella*, were common in white and Sitka spruces in parts of the Prince Rupert and Cariboo regions and infested up to 72% of the Engelmann spruce cones in the Nelson Region. A spruce cone rust, *Chrysomyxa pirolata*, infected 10% (range 3-18%) of the Engelmann spruce cones in three stands in the Nelson and Cariboo regions but was not evident in other regions. Lodgepole pine cones examined from the Prince Rupert and Prince George regions were virtually pest-free.

Western white pine cone crops were assessed at 64 locations in the Kamloops, Nelson and Vancouver regions including Vancouver Island in support of a cooperative research study. In the

West Kootenay and in the Kamloops Regions, most (80%) of the cone crops were medium to heavy. Light crops were recorded at most of the 17 sites in the Vancouver Region.

Acid rain monitoring

The recent recognition of the potential for forest damage in British Columbia from low pH rainfall and the occurrence of some sensitive soils of low buffering capacity resulted in the establishment of a nationally standardized series of forest plots in 1984. These constitute the CFS-FIDS Acid Rain National Early Warning System (AR-NEWS). Baseline knowledge to be obtained from the plots includes the concentration of foliar and soil elements, foliar condition and tree growth and the detection and monitoring of possible changes.

Three plots were established in southwestern British Columbia in 1984. Six additional permanent plots were established in five forest regions in 1985: at Campbell River and near Chilliwack in the Vancouver Region; near Penticton in the Kamloops Region; near Castlegar in the Nelson Region; northeast of Prince George and near Terrace in the Prince Rupert Region.

Observations were made by FIDS rangers at 65 permanent sample stations (PSS), mainly in the Nelson and Kamloops regions, in addition to the 417 province-wide PSS's surveyed last year. Numerous ground cover species and about nine tree species were observed during assessments which were distributed among soil sensitivity zones: 74% low, 6% moderate and 20% high. All sites were in the less than 10 kg/ha/yr wet sulphate deposition zone.

Trees were generally healthy in 90% of the PSS's. Thin crowns, frequently associated with recent insect feeding, were the major symptom on 10% of the sites, principally those in the Thompson River drainage in the Kamloops Region. Symptoms reported to be typical of acid rain damage in West Germany including premature discoloration and shedding of needles, abrupt decline in foliage or annual ring growth, unexplained die-back, flattening of tree crowns, etc., were not evident. All obvious damage encountered could be accounted for by current or previous pest conditions.

Deciduous and ornamental tree pests

Tent caterpillars

Malacosoma disstria, *M. pluviale*

The area of trembling aspen defoliated by forest tent caterpillar, *M. disstria*, in 1985 (Map 3) increased in the Peace River area and in the West Kootenay and declined slightly in the Prince Rupert Region, but collapsed in the Salmon River Valley north of Prince George.

Trembling aspen and some balsam poplar were severely defoliated over 58 000 ha in the Peace River area from south of Pouce Coupe to Fort St. John, the third successive year of defoliation. After two years of defoliation in the Salmon River Valley, populations collapsed from natural control factors. Moderate and severe defoliation of trembling aspen covered 900 ha between Kitwanga and Moricetown in the Prince Rupert Region for the third successive year. In the West Kootenay near Trail and Warfield, about 125 ha of cottonwood, trembling aspen, birch and other deciduous hosts were moderately or severely defoliated for the second consecutive year.

Egg masses in recently infested stands in the Peace River area, between Hazelton and Kitwanga, indicate continuing moderate and severe defoliation in 1986. There was little evidence of significant natural control factors.

Colonies of western tent caterpillar, *M. pluviale*, were more numerous and widespread in south-western British Columbia than in 1984. Light to severe defoliation of a variety of deciduous trees and shrubs including alder and birch was common from Surrey and Delta through North and West Vancouver to Horseshoe Bay on the Vancouver Lower Mainland, and from Victoria to Campbell River on Vancouver Island. Little change is expected in 1986.

Satin moth

Leucoma salicis

Increased populations of this introduced insect severely defoliated trembling aspen, cottonwood and ornamental deciduous trees in the Kamloops

and Nelson regions, in Victoria and, for the first time, in the Cariboo Region.

Moderately defoliated cottonwood in a residential area of Williams Lake was the first record of the defoliator in the Cariboo Region, a northward extension from Cache Creek.

In the Kamloops Region 1 to 100 ha patches of trembling aspen were severely defoliated south of Chase and near Merritt and Logan Lake. About half the foliage of the cottonwood and willow over 15 ha was consumed at Moyie townsite in the Nelson Region, but defoliation was less severe than in the previous two years. Widely scattered stands of aspen and cottonwood and some deciduous ornamentals were lightly or moderately defoliated in the West Kootenay near New Denver, Silverton and Anarchist Mountain. Defoliation was not evident, however, along the west arm of Kootenay Lake and in Nelson where large moth flights occurred in 1984. In Victoria, increased localized populations lightly defoliated boulevard ornamentals.

Populations are expected to continue at similar levels in 1986.

A birch leaf skeletonizer

Lyonetia salicella

Discoloration of western white birch was severe in parts of the Nelson, Prince George and Kamloops regions, for the seventh consecutive year in some areas. Most affected trees refoliated by late summer with little evidence of branch or tree mortality even after repeated years of severe discoloration.

Severe discoloration of birch was conspicuous along Horsethief and Bugaboo creeks in the Nelson Region, in the Columbia River Valley north of Radium Hot Springs and from Yoho to Mt. Revelstoke National Park.

East of Tete Jaune Cache to Mt. Robson in the Prince George Region most birch stands were severely discolored by larval feeding. Stands

south of Valemount to Albreda were less severely damaged, however there was little evidence of populations or damage in the McBride area, where light defoliation occurred in 1984.

In the Kamloops Region discoloration of 40 to 100% of the foliage in 1 to 50-ha birch groves by increased skeletonizer populations was common and totalled over 3 100 ha from Barriere east to Adams Lake.

Poplar leaf diseases

For the ninth consecutive year, trembling aspen stands and some cottonwood in parts of the Prince Rupert Region were severely discolored by poplar leaf and shoot blights, *Venturia* spp. Premature leaf drop of trembling aspen caused by *V. macularis*, occurred over 12 000 ha mainly on southerly aspects from east of Kitwanga to Cedarvale; infections declined in the eastern part of the Region. Infections by *V. populina* were light on black cottonwood in the Skeena River Valley from Cedarvale to Terrace and in the Kiti-mat River Valley. Conifer-cottonwood rust, *Melampsora occidentalis*, discolored black cottonwood seedlings and saplings causing premature leaf drop in the Skeena River Valley from Hazelton to Terrace, in the Kalum River Valley, and from Kitwanga north to Cranberry Junction.

Gypsy moth

Lymantria dispar

Following the discovery by Agriculture Canada-Plant Health of small numbers of moths, egg masses and larvae at Courtenay in 1983 and 1984 and at Chilliwack in 1984, small areas were aerially sprayed in 1985 using *Bacillus thuringiensis* (B.t.). In a cooperative pheromone trapping survey 6000 traps were distributed province-wide. Although adult male moths were not trapped at Courtenay in 1985, 14 were trapped at Chilliwack near the Canadian Forces Base, 1 at Cultus Lake, 1 near Abbotsford and 1 about 4 km north of Cache Creek. None were found in 142 forested recreational areas throughout the province monitored for the eleventh year by the Canadian Forestry Service's Forest Insect and Disease Survey. Monitoring in forested areas by the B.C. Ministry of Forests was also negative.

To date, populations have not become established in British Columbia and defoliation has not been observed. Although ornamental and urban trees could be severely defoliated as populations become established, the major concern of the forestry sector continues to be potential quarantine restrictions such as those in parts of Oregon where extensive gypsy moth populations were found for the first time in 1984 and required a large, costly control program.

Pheromone trapping programs and, if necessary, egg mass surveys will continue in 1986 in cooperation with Agriculture Canada.

Winter moth

Operophtera brumata

Defoliation of deciduous trees and shrubs in Greater Victoria, Saanich Peninsula and Western Communities declined significantly to light or very light. Parasites were released between 1979 and 1982. The high incidence of the introduced parasite, *Cyzenis albicans*, is a major factor in the decline which comes after fourteen consecutive years of defoliation. About 44% of the winter moth populations at 33 sites were parasitized, about the same as in 1984.

Up to 60 larvae were collected in samples from trees very lightly infested in 1984 on Saltspring Island and Duncan. Larvae were collected for the first time at Nanaimo.

Pheromone-baited traps are being tested for the first year at 25 sites between Sooke and Campbell River and between False Creek and White Rock and near Tsawwassen. Results confirm the presence of winter moth between Victoria and Nanaimo and at Tsawwassen and Richmond. Adults were not found in traps north of Nanaimo, at Sooke, White Rock nor in the False Creek area in Vancouver.

Dogwood leaf blotch (Anthracnose)

Gloeosporium sp.

Infection of dogwood trees in east coastal areas of Vancouver Island and the Vancouver Mainland was common but less severe than in 1984; flowering was normal. Discoloration of infected foliage was mainly within the lower crowns of affected

trees. Following several years of severe infection, branch dieback was evident on up to 10% of the trees in some areas on Vancouver Island.